Acta Mineralogica-Petrographica, Szeged XXI/1, 21—39, 1973

SEDIMENTARY FEATURES OF THE TRANSGRESSIVE NEOGENE SEQUENCES OF THE SOUTHERN GREAT HUNGARIAN PLAIN*

K. BALOGH

L. LÓCZY SR. [1916] was the first, to be followed later by K. TELEGDI ROTH [1929, pp. 135—138], who drew the consequences of the fact that in the southern and southeastern marginal mountains surrounding the Pannonian Basin the Mesozoic or pre-Mesozoic basement is overlain immediately, with absence of the Palaeogene, by Middle Miocene marine sequences. The essence of their conclusions that the Neogene seas had from the Upper Mediterranean on gradually inundated the Palaeogene land wich occupied the greatest part of the today's Great Hungarian Plain is confirmed by the newest syntheses [G. HÁMOR, Á. JÁMBOR, 1971; L. KŐRÖSSY, 1968; M. SZÉLES, 1971]. The development is still incontestably remarkable, for in the light of numerous wells undertaken in the last four decades, a number of details of LÓCZY—TELEGDI ROTH's ideas has now become a tangible reality. On account of this, our knowledge of the age, nature, dimensions and trends of Neogene transgressions has been considerably widened. As evidenced convincingly by the regarding isopach maps, the Great Hungarian Plain's Neogene basin must have consisted of several subbasins wich subsided at varying rates. Lithological investigations, in turn, testify to the fact that these subbasins had been separated by islands of different size before the subsidence became an overall phenomenon. In a number of cases excellent hydrocarbon traps have developed in the pseudo-domed hanging sequences of these former islands that, in spite of their subsequent burial, still remained higher compared to the surrounding basement.

The fate of the islands was naturally different in dependence on their position. Some of them were inundated already during Tortonian transgression and at the time of the expansion of the Early Pannonian inland sea they formed already only subaquatic ridges (e. g. one of this kind seems to have been the basement of the Kiskundorozsma and Szeged structures). On the other hand, in the case of the Algyő structure a little farther east, only the western limb could be shown to include Miocene deposite, but the overwhelming majority of the core of the structure still formed an island at the beginning of the Pannonian. Lower Tortonian and Lower Pannonian sedimentation are not only chronologically separated from each other, but there is also a considerable facies-difference between the two due to dimensions, connections, salinity, fossil content, etc. In spite of this fact (at least in the area men-

* The material here presented has been processed by the staff of the Department of Geology and Palaeontology of József Attila University, Szeged, on a contract concluded with the National Trust of Oil and Gas Industry. For the permission of publication of the results, most sincere thanks are due to the Trust's Board.

tioned above), a striking similarity can be recognized between the sedimentary features of the transgressive sequences of the Early Tortonian sea on the one hand and the Early Pannonian inland sea on the other.

1. The *Tortonian sequence* begins with a massive, frequently breccia-like basal conglomerate overlying a basement consisting of cristalline schists at Dorozsma and of crystalline schists and Lower and Middle Triassic sediments at Szeged (Plate I, *Fig. 1* and *2*). Poorly sorted and rounded, attaining 5, 7 or even 12 cm in diametre, the coarse pebbles of this conglomerate are embedded in coarse-grained sandstones or fine-grained conglomerates. The rock grains reflect the composition of the environment of their accumulation. Accordingly, at Dorozsma they consist of chloritic micaschist and quartzite. At Szeged (at least in the more northern boreholes), however, the fragments of metamorphite fall into the background against the grains of the dark-grey Middle Triassic dolomites, purple-red Seisian sandstones and green Werfenian shales and dolomitic marls, and in the poor sandstone cement dolomite and quartz predominate as well. However dissimilar to be the rock of Szeged looks as compared to that of Dorozsma, the variegated colour and composition have obviously been caused merely by local changes in the lithology of the source area, changes reflecting the combined effect of pre-transgression tectogenesis and erosion. Despite their substantial differences, the two rocks must have been produced by a rapid deposition under essentially the same environmental conditions.

Above the breccia-like basal conglomerates the Szeged oil wells have uncovered a member, that may be named as the whole a fine conglomerate, whose well rounded pebbles are enclosed in a light-grey, ill-sorted, poorly muscovitic and usually limeless dolomite—quartz sandstone (Plate I, *Fig. 3, 4*; Plate II, *Fig. 1—4*). The pebbles vary between 2—15—36 mm in diametre, though sometimes attain even >70 mm. For the most part, they consist of dark-grey Middle Triassic dolomites, for the smaller part, of quartzite, whereas the Werfenian and crystalline schist pebbles are sparse and small, with a max. diametre of 6 mm. Between heavily gravelly details there are lenses and sections, usually irregular and characterized by a relative enrichment of the cement. Although good bedding planes cannot even here observed, the pulsating alternation of gravelly and sandy details is nevertheless an indication of a graded bedding trend (Plate II, *Fig. 3*). For the lack of perfect grading, the turbulence of the settling medium, continuous, but barying as to intensity, seems to have been responsible. The thicker gravel streaks and lenses are obviously the results of temporary increase of sediment production and transport. Frequently, however, sandstone-filled, erosion-made cavities sink into the gravel bands (Plate II, *Fig. 1*). The distribution of the coarser sand grains and pebbles in the poorly sorted sandstones overlying the gravel bands often displays a "mesh-like pattern" indicative of horizontal vortices (Plate I, *Fig. 3—4*, Plate II, *Fig. 1—2*). The centre of each "mesh", more or less circular in cross-section and of 1,5 to 3 cm in diametre, is usually filled by finer fractions of sandstone, though a few, less coarse grains may also here occur. The grain size, however, increases towards the periphery of the meshes so that the coarsest grains are always situated on the most external side of those. Both the erosion channels and the mesh-like structures testify to a strirring up and displacement of the sediment formerly settled down. The vertical and oblique vortices scourring the bottom picked up the grains already settled down and carried them away; these of subhorizontal axis, however, lifted the sediment on their ascending branch and dropped it on the descending one. Since the velocity of the water is along the outside of the vortex is higher than in the inside of that, the distribution of the grains of the mesh-like structures has developed in accordance with this. The scenery of the phenomenon must have been an abrasion plane brought about during the progress of the transgression whose continuous water movement rendered possible partly the disintegration and rounding of the produced debris, partly the formation of the above-mentioned turbidity structures. With the increase of the distance to the coastline, however, the intensity of water movement connected with the surf zone generally decreased and, in accordance with this, with the intervention of finer and finer grain fractions, a more and more perfect graded bedding could develop (Plate II, *Fig. 4*). The resultant shallow-water turbidities, with an additional rapid decrease in grain size, will pass into black marls through sandstone and siltstone, relatively thin and partly massive and poorly graded, partly showing up graded or composite bedding.

The Tortonian marl is a formation of euxinic character, more or less de-clay-mineralized during diagenesis, consisting of alternating fine-grained sands, siltstones, marls and limestones and containing both bacteriopyrite and its limonitic weathering product as well as a little organic matter (Plate III, *Fig. 1—2*). Frequently, even the lime-rich members are interrupted by quartz- and muscovite-rich, fine laminae. Because of its fine-bedding, locally some folding indicative of subaqueous slumping or sediment-flow can be recognized (Plate III, *Fig. 2*). The marl sequence evidences the sudden decrease of the rate of the sedimentation along with a considerable refinement of the grains. All these facts, together with other sedimentary features, indicate the coastline to have been displaced far away and the basin to have rapidly deepened. Containing *planctonic foraminifers,* the marls can be considered the sediment of a quiet, offshore environment rather than that of a more or less land-locked bay.

The sediments of the Tortonian sea overlying the marl sequence have been eroded. It looks probable, however, that above this sequence an alternation of laminae of black argillaceous siltstones and light-grey, small-grained sandstones ought to follow, similar to those found in the well Hódmezővásárhely—1. The sedimentary structures of the latter remember that of the higher part of the Lower Pannonian, with frequent deformations due to subaqueous slumping (Plate III, *Fig. 3*).

2. The *Lower Pannonian sequence* is introduced by two facies replacing each other.

At the beginning of the Pannonian, on the margins of the elevations still forming islands, basal conglomerates and sandstones similar to those of the Tortonian, coarser at the base and gradually decreasing in grain size up in the profile, though always poorly graded and poor in calcium carbonate, were deposited. The composition of these sediments is controlled by the lithology of the basement. This occurs in the studied area only on the limbs of the Algyő structure and following the local conditions, its substance is identical with that of the underlying crystalline schist basement (pegmatite, quartzite and garnet-bearing chloritic schist: Plate III., *Fig.4*; Plate IV. *Fig. 1*). The coarse conglomerates and sandstones vary in proportions from area to area. This sequence differs from the Tortonian basal formation mainly by the relatively rapid decrease of the grain size. Responsible for the pinching out of the sandstone-dotted fine conglomerate bands, this phenomenon can be explained either by that the rocks of the source area have been more liable to chemical weathering, or by the relatively low abrasion energy of the Early Pannonian inland sea, or by a combination of the two. At any rate, no wide abrasion terrace that might have ensured a heavy rounding for the majority of the coarser grains had been formed there at that time.

However, this fact as well as the sudden subsidence of the Algyő island seems to account for the observation that the basal detritus of the Lower Pannonian is separated from the overlying dark-grey to black marls and limestones merely by a few meters of grey fine-sandy, calcareous siltstone. Although the transitional siltstone sequence lacks any good bedding plane, on account of the recurrence of the coarse sandstone and grit bands and the "cloudy distribution" of the coarser grains atop it does yet exhibit a distinct graded beding (Plate IV. *Fig. 3*). And in order to avoid any doubt as to the shallow-water turbidite nature's being due to the turbidity of the sedimentary environment and to the repeated stirring up of the clastic material streaming in from time to time from the coasts, let us point out that in some samples even the mesh-like eddy structures described above from the higher parts of the Tortonian basal conglomerates can be recognized. Although these do not attain the size of the Tortonian structures and though the "meshes" form just a single row, the genesis of the phenomenon is, perhaps exactly therefore, all the more clear (Plate IV, *Fig. 2*).

The dark-grey marl and calcareous marl sequence, of slightly brownish shade sometimes, is similar to the Tortonian marl sequence both in colour, organic contents, pyrite or limonite contents and the locally recognizable, discontinous horizontal lamination. Exactly for this reason it can be distinguished undoubtedly from the Tortonian marls only on the basis of its foraminiferal sterility, respectively contents of *Congeria* or *Limnocardium,* in spite of the fact that every variant of it contains essentially more detrital material (quartz and muscovite grains) as compared to the formers. Its lamination is usually connected with graded bedding (Plate IV, *Fig. 4*). The marls and calcareous marls of the wells Algyő-17, -19, -27, -88 and -90 rest with spreading transgression, directly on the crystalline basement. In the basin portions, subsiding more rapidly and thus deeper, between the islands, where the littoral conglomerates and sandstones are also missing, it occurs as a formation replacing the latters. On account both of its position corresponding to Walther's facies-rule, and of its sedimentary features respectively abundance in *Hystricho-sphaeridae* and *Peridineae,* it can be regarded as sediment of a quiet, but offshore realm.

The continued subsidence of the basin is indicated by the appearance of dark-grey, thin-bedded, and even shaly, argillaceous siltstones and clay-marls (Plate V, *Fig. 1*). On the basis of its more reduced $CaCO_3$-contents and finer grain size it is really this facies that may having been deposited when the Lower Pannonian basin attained its greatest depth.

In the overlay of the clay-marl sequence, the monotonous succession of these fine-grained sediments, testifying to a steady subsidence, is followed by a varied sequence of coarser and finer sediments that alternate on very different ways. This sequence was referred to a "sandy horizon" and "sandy claymarl horizon" by L. Kőrössy [1968]. These distinctions of Kőrössy, however, are valid in rough lines only, for in a number of sections the Lower Pannonian as a whole is found to be marly including only thin sandstone intercalations. Obviously, we have to do here with facies replacing one another variedly. Their distribution has been controlled by the extension and energy and turbulence conditions of the currents of water that used to divide the coarser sediments in the more internal parts of the basin. Accordingly the manner of bedding is very variegated. In addition to laminations of varying thickness, continuous or discontinuous and parallel—horizontal (Plate V, *Figs. 2—4*), crossbedding of varying dip can frequently be encountered, being connected with the migrating of flatter or steeper ripples on the basin floor. The foresets of the flatter ripples have often been preserved only in the form of thin siltstone or claystone flasers (Plate VI, *Figs. 1—2*). In other case, the most different phases of the truncation and planation of the ripples can be met with. Accordingly, every sand lense embedded in a clayey or silty rock can be considered to be the remnant of a minor sand wave (see Plate VI, *Figs. 3—4,* Plate X, *Fig. 4* and Plate V, *Fig. 4* in the given succession).

Periodical increase of the turbidity of the currents can be read off those poorly sorted sandstone bands too wich are intercalated in several centi- or decimeter thickness between the parallel—horizontal or lenticular laminae (Plate V, *Fig. 4,* Plate VI, *Fig. 1* and *3*; Plate VIII, *Figs. 1—2*). In accordance with this phenomenon these sandstone sections frequently abound in silt(stone) or clay(stone) pebbles undoubtedly underwent transportation (Plate VII, *Fig. 2,* bottom; Plate VIII, *Figs. 1—2,* top; Plate IX, *Fig. 5*).

The rectilinear grading of some sandstone bands (Plate VI, *Fig. 4,* lower part), however, indicate the turbidity current to have gradually decreased in energy.

As a result of the combination of the afore-mentioned types a composite bedding has developed in many cases (Plate VI, *Fig. 4*; Plate X, *Fig. 4*).

Differential load due to sand waves thicker in the centre has brought about load casts and compensating flame structures in the fine mud that was originally still filled with water (Plate VI, *Figs. 3—4*). In consequence of the sinking of the primarly emerging (positive) forms into the mud, the differential load produced diversified convolutions of the foresets (Plate IX, *Fig. 1*). This kind of sedimentary deformation, however, often occurs even in cases when no trace of sand wave formation is available (Plate V, *Fig. 3*; Plate VII, *Figs. 1—3*; Plate VIII, *Figs. 1—2*). In such cases one has to think the freshly deposited sediment to have been shaken (e. g. as a result of an earthquake due to the subsidence of the sedimentary basin).

Folds (Plate IX, *Fig. 2*) due to subaquatic slumping and sliding respectively faults (Plate IX, *Fig. 3*) due to foundering of the sediment also occur frequently in the Lower Pannonian sequence. The resultant convolution structures (Plate X, *Fig. 4,* bottom) cannot always be distinguished sharply from the convolutions due to differential load (see also Plate VIII, *Figs. 3—4*).

On account of the close interconnection between their occurings, the silt(stone) and clay(stone) pebbles, so frequent in the sandy members of the Lower Pannonian and often showing up proper internal structures (Plate IX, *Figs. 4—5*; Plate X, *Figs. 1—2*), should be supposed to have been in genetical connection with slumpings due to synsedimentary tectonism. Unlike usually believed, we do not think that these might be inferred from mud curls or flakes formed by desiccation during ebbs or, in general, at low water stage. The present writer believes that — at least in this case — sediment-fragments of partly already consolidated state torn away by subaqueous slumping and these were brought to site of their deposition by water current suddenly accelerated by the slumping itself. This is evidenced by the fact that they can always be found within coarser sediments whose appearance can be referred to strong water currents. Of course, it is possible that subaqueous slumping is a polygenetic phenomenon wich can be provoked also by changes in the direction or intensity of primary water current. The formation and transport of the silt(stone) pebbles, however, must be regarded by all means as a consequence of slumping.

The most direct marks of the resultant currents, however, are represented by flute casts (Plate X, *Fig. 3*). Even though occasionally load-casted, the furrows and fillings of these can be readily recognized in most of the cases.

All these sedimentary features of the Lower Pannonian of the southern Great Hungarian Plain seem to be absent in the marginal sequences of the same age. The similarity of these features to those of the marine Tortorian sediments uncovered in the same region indicates that the two transgressions must have had the same mechanism with currents formed under conditions of subequal depth and bottom relief.

REFERENCES

HÁMOR, G.—JÁMBOR, Á. [1971:] A magyarországi középsőmiocén. (Das Mittelmiozän Ungarns) — Földtani Közlöny 101, pp. 91—102.

KŐRÖSSY, L. [1968]: Entwicklungsgeschichtliche und paläogeographische Grundzüge des ungarischen Unterpannons. — Acta Geol. Ac. Sci. Hung., 12, pp. 199—217.

LÓCZY, L. SEN. [1916]: Die geologischen Formationen der Balatongegend und ihre regionale Tektonik. — Res. wissensch. Erforsch. Balatonsees 1, 1, 1, Wien, 716 p.

SZÉLES, M. [1971]: A Nagyalföld medencebeli pannon képződményei. — A magyarországi pannonkori képződmények kutatásai. — Akadémiai Kiadó, Budapest, pp. 253—344. (In Hungarian)

TELEGDI ROTH, K. [1929]: Magyarország geológiája. I. — Tud. Gyűjt., 104, Pécs, 170 p. (In Hungarian)

VÖLGYI, L., S. SUBA, K. BALLA, I. CSALAGOVITS, [1970]: Algyő. — Magyarország szénhidrogén telepei. — Az OKGT kiadása, Budapest, 423 p. (In Hungarian)

Manuscript received, May 10, 1973

PROF. DR. KÁLMÁN BALOGH

Department of Geology
and Palaeontology
Attila József University
H—6722 Szeged , Táncsics M. u. 2., Hungary

EXPLANATION OF THE PLATES I—X

PLATE I

1. Coarse, massive, poorly sorted coastal conglomerate consisting of pebbles of crystalline schists. — Lower part of the Tortonian basal conglomerate complex. — Well Dorozsma-4. 2937,30—2937,44 m. Side-view.

2. Coarse, massive, poorly sorted, polymict breccia composed prevailing of fragments of Triassic rocks. — Lower part of the Tortonian basal conglomerate complex. — Well Szeged-7. 2828,71—2829,00 m. Polished surface.

3—4. Mesh-like eddy structures formed by horizontal vortices. — Middle part of the Tortonian basal conglomerate complex. — Well Szeged-2. 2666,00—2679,50 m. Side-view.

Plate II

1. Outwash and mesh-like eddy structures from the middle part of the Tortonian basal conglomerate complex, on the contact of lenses of fine-grained dolomite-conglomerate and coarse dolomite—quartz sandstone. — Well Szeged-2. 2666,00—2679,50 m. Polished surface.

2. Mesh-like eddy structures formed by small dolomite pebbles, in the faintly calcareous dolomite — quartz sandstone of the middle part of the Tortonian basal conglomerate complex. — Well Szeged-2. 2666,00—2679,50 m. Polished surface.

3. Poorly sorted, medium-grained dolomite-sandstone with lenses of dolomite-pebbles. — Upper part of the Tortonian basal conglomerate complex. — Well Szeged-7. 2788,90—2789,12 m. Polished surface.

4. Four directly sorted small rhythm from the upper part of the Tortonian basal conglomerate complex. — Well Szeged-7. 2780,35—2780,60 m. Polished surface.

Plate III

1. Parallel—horizontal lamination in the fine-sandy and silty marl beds of the Tortonian marl complex, with pyrite lenses seeming on the picture to be white. — Well Szeged-2. 2656,00—2665,00 m. Polished surface.

2. Folding in the dark-grey and black, discontinuous-horizontal laminae of the Tortonian marl complex suggesting mud flow. — Well Szeged-2. 2656,00—2665,00 m. Polished surface.

3. Folding deformation caused by submarine slumping of the originally parallel-horizontal laminae of the black argillaceous siltstone and light-grey, fine-grained sandstone in the somewhat higher part of the Tortonian complex. — Well Hódmezővásárhely-1. 5654,00—5654,30 m. Side-view.

4. Coarse, massive, poorly sorted conglomerate from the lower part of the Lower Pannonian basal conglomerate complex consisting of pebbles of crystalline schists. — Well Algyő-91. 2535,82—2536,09 m. Side-view.

Plate IV

1. Massive, poorly sorted, coarse sandstone with small pebbles. — Higher part of the Lower Pannonian basal conglomerate complex. — Well Algyő-50. 2500,00—2500,92 m. Side-view.

2. Mesh-like eddy structures formed by the stir up of the deposited sediment in a coarser intercalation of a fine-grained sandstone. — Top of the basal conglomerate complex of the Lower Pannonian. — Well Algyő-248. 2724,06—2724,25 m. Side-view.

3. „Cloud-like transition" between stripes of the fine-sandy calcareous siltstone and the interbedded coarse sandstone formed by the stir up of the deposited sediment. — Direct cover of the Lower Pannonian basal conglomerate complex. — Well Algyő-85. 2864, 97—2865,17 m. Side-view.

4. Discontinuous-horizontal lamination: above coarser, below finer-grainded laminae of marl in the marl complex of the Lower Pannonian. — Well Szeged-2. 2593,18—2593,58 m. Polished surface.

Plate V

1. Dark-grey, thin-bedded, fissil argillaceous siltstone. — Higher part of the Lower Pannonian. — Well Algyő-82. 2489,35—2489,57 m. Side-view.

2—3. Dark-grey, calcareous siltstone, with horizontal-parallel laminae of a light sandstone. On the bottom surface of some of the thicker sandstone-laminae small load pockets and flame structures. — Higher part of the Lower Pannonian. — Well Szeged-9. 2528,55—2228.70 m. Side-view.

4. *Below:* Dark-grey siltstone, interbedded with thin, horizontal-parallel bands and lenses of sandstone. *Above:* Covering the formers, light-grey, massive, fine- and small-grained calcareous sandstone with muscovite flakes. — Higher part of the Lower Pannonian. — Well Szeged-9. 2714,69—2714,87 m. Side-view.

PLATE VI

1. Flaser-structure in a small-grained sandstone interbedded with argillaceous marl. — Higher part of the Lower Pannonian. — Well Ferencszállás-13. 2508,32—2508,70 m. Side-view.
2. Siltstone-flasers among ripples of a light-grey, fine- and small-grained sandstone having a flate cross-bedding. — Higher part of the Lower Pannonian. — Well Ferencszállás-6. 2260,50—2260,65 m. Side view.
3. Cross-bedded ripple intercalated between horizontal-parallel beds. — Higher part of the Lower Pannonian. — Well Szeged-7. 2335,30—2335,43. Side-view.
4. Development of a discontinuous, lense-like structure formed both by sunk and planed, cross-bedded ripples, from a horizontal-parallel laminated sandstone. The thick lense in the upper part of the picture represents a sunk ripple. — Higher part of the Lower Pannonian. — Well-Szeged- 9. 2467,66—2467,85 m. Side-view.

PLATE VII

1. Contact between a grey siltstone and a fine- and small-grained sandstone band, with load marks and compensating flames. — Higher part of the Lower Pannonian. — Well Algyő-82. 2485,22—2485,30 m. Side-view.
2. Large load marks of a lighter-grey, coarse sandstone sunk into a fine -grained sandstone with siltstone lenses. — Higher part of the Lower Pannonian. — Well Algyő-82. 2486,12—2486,21 m. Side-view.
3. The plane of the fine-grained sandstone pictured on the Fig. 2., with moulds of load pockets.

PLATE VIII

1—2. Flame-structures in a sandstone, that alternates below with thin siltstone-stringers, but includes above siltstone-pebbles. — Higher part of the Lower Pannonian. — Well Szeged-2. 2416,93—2417,16. m. Side-view.

3—4. Dark clay marl with sunken parts of the covering fine-grained sandstone, partly dissected by mud-flasers. — Higher part of the Lower Pannonian. — Well Ferencszállás-13. 2390,85—2391,05 m. Side-view.

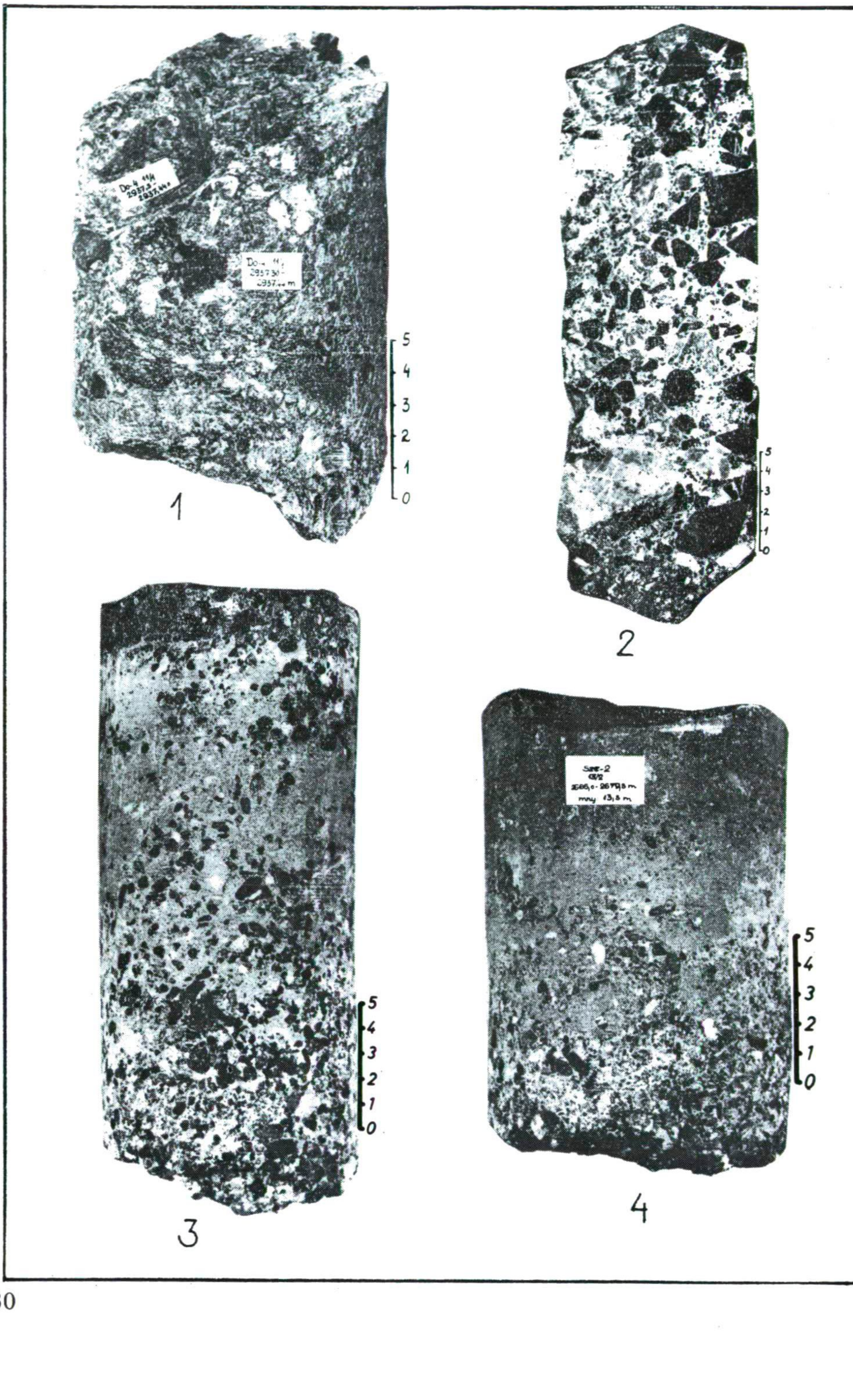
PLATE IX

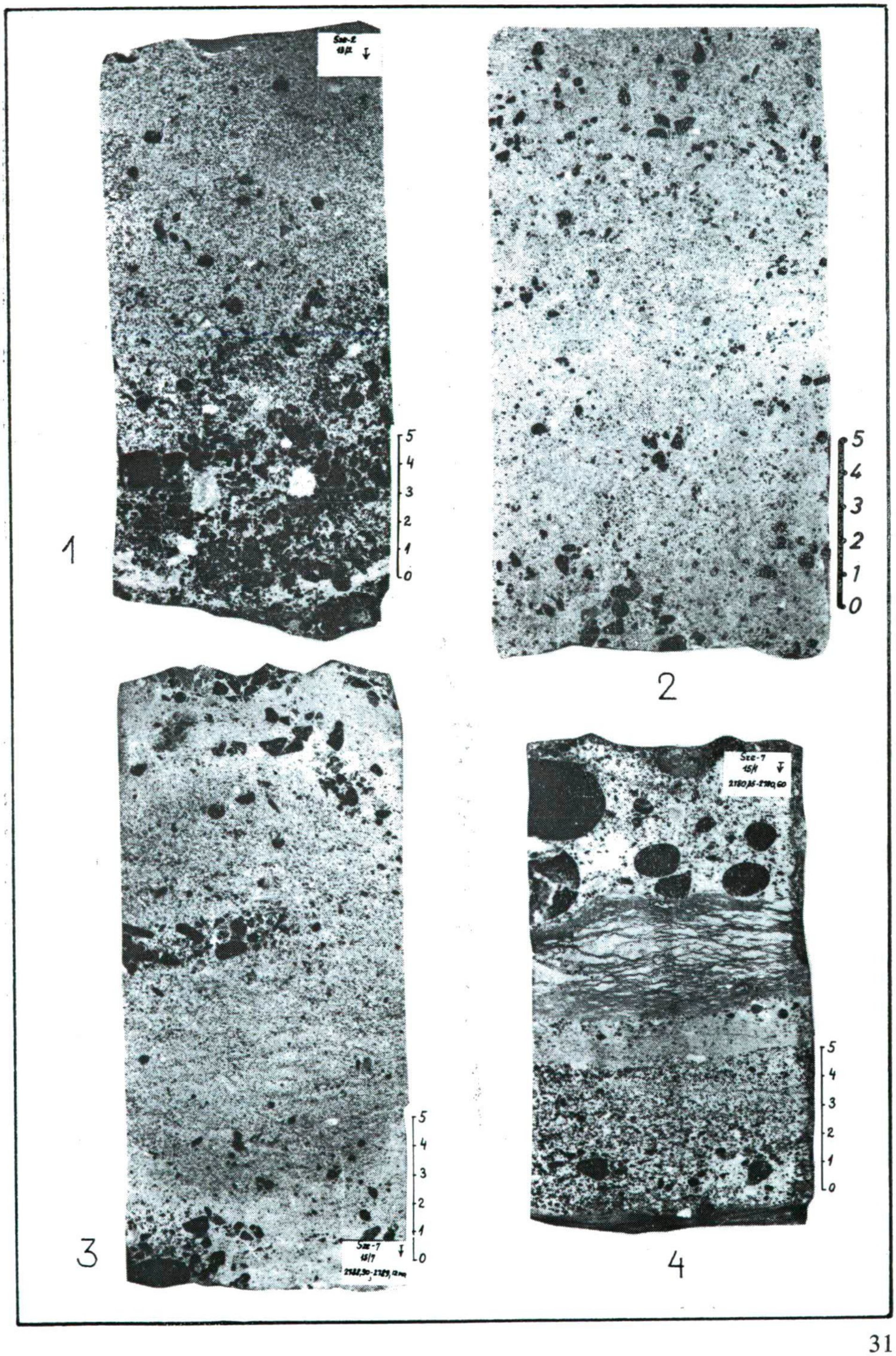
1. Convolution of sand waves sunken by differential load into the underlaying siltstone. — Upper Pannonian. — Well Algyő-242. 1965. m. Side-view.
2. Folding caused by sub-aqueous slumping in alternation of fine- and coarse-grained siltstone-laminae with that of fine- and small-grained sandstone. — Higher part of the Lower Pannonian. — Well Ferencszállás- 13. 2214,31—2214,62 m. Polished surface.
3. Minor sedimentary fault crossing horizontal-parallel laminae of sandstone interbedded with argillaceous siltstone. — Higher part of the Lower Pannonian. — Well Algyő-86. 2422,50—2422,84 m. Side-view.
4. Biscuits of fine-grained siltstone with proper lamination, embedded in a poorly sorted, coarse- and fine-grained sandstone. — Higher part of the Lower Pannonian. — Well Szeged-9. 2465,40—2466,40 m. Polished surface.

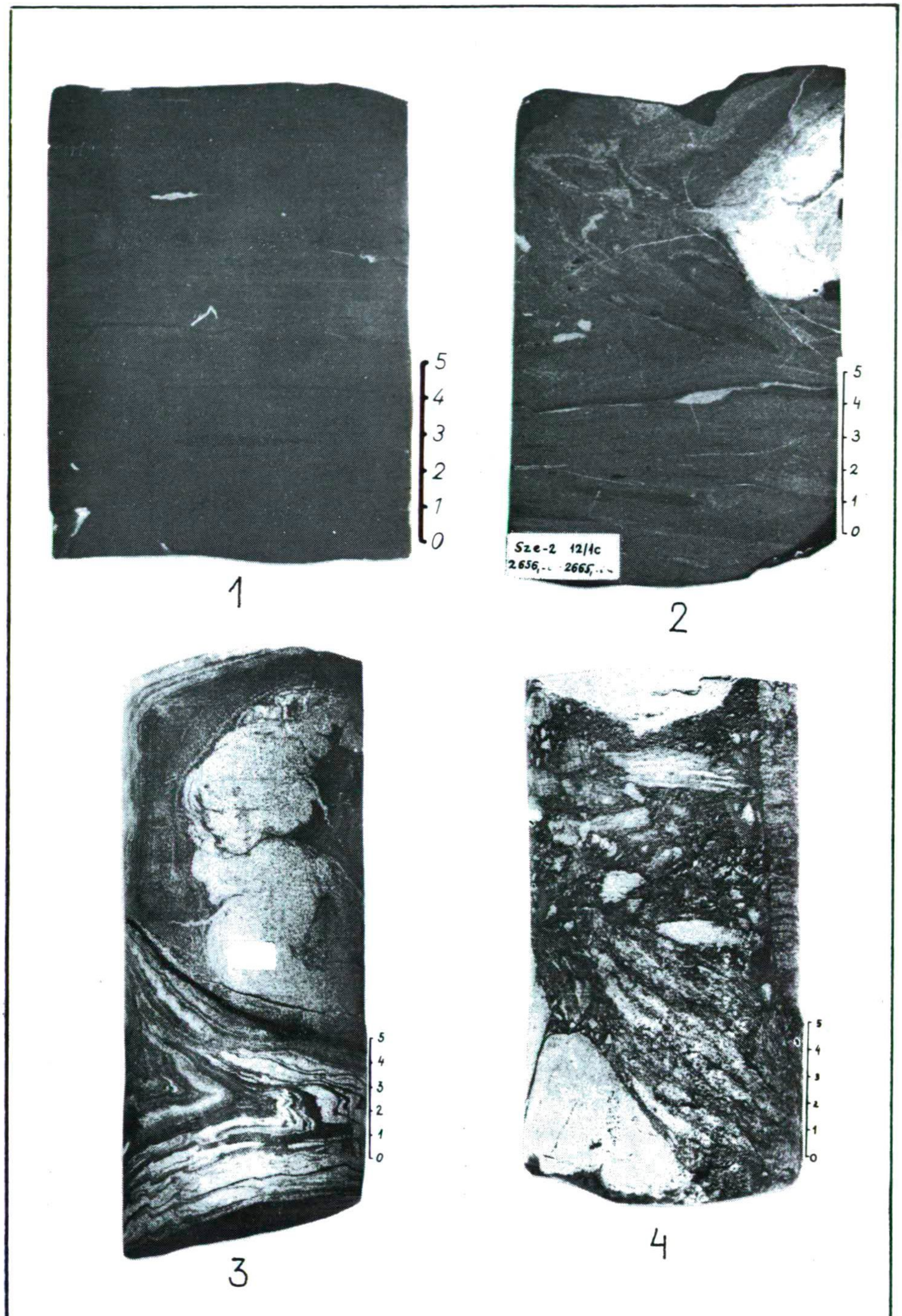
5. Minor siltstone pebbles and current ripple foreset-bedding in a poorly sorted sandstone. — Higher part of the Lower Pannonian. — Well Szeged- 9. 2465,10—2465,40 m. Side-wiev

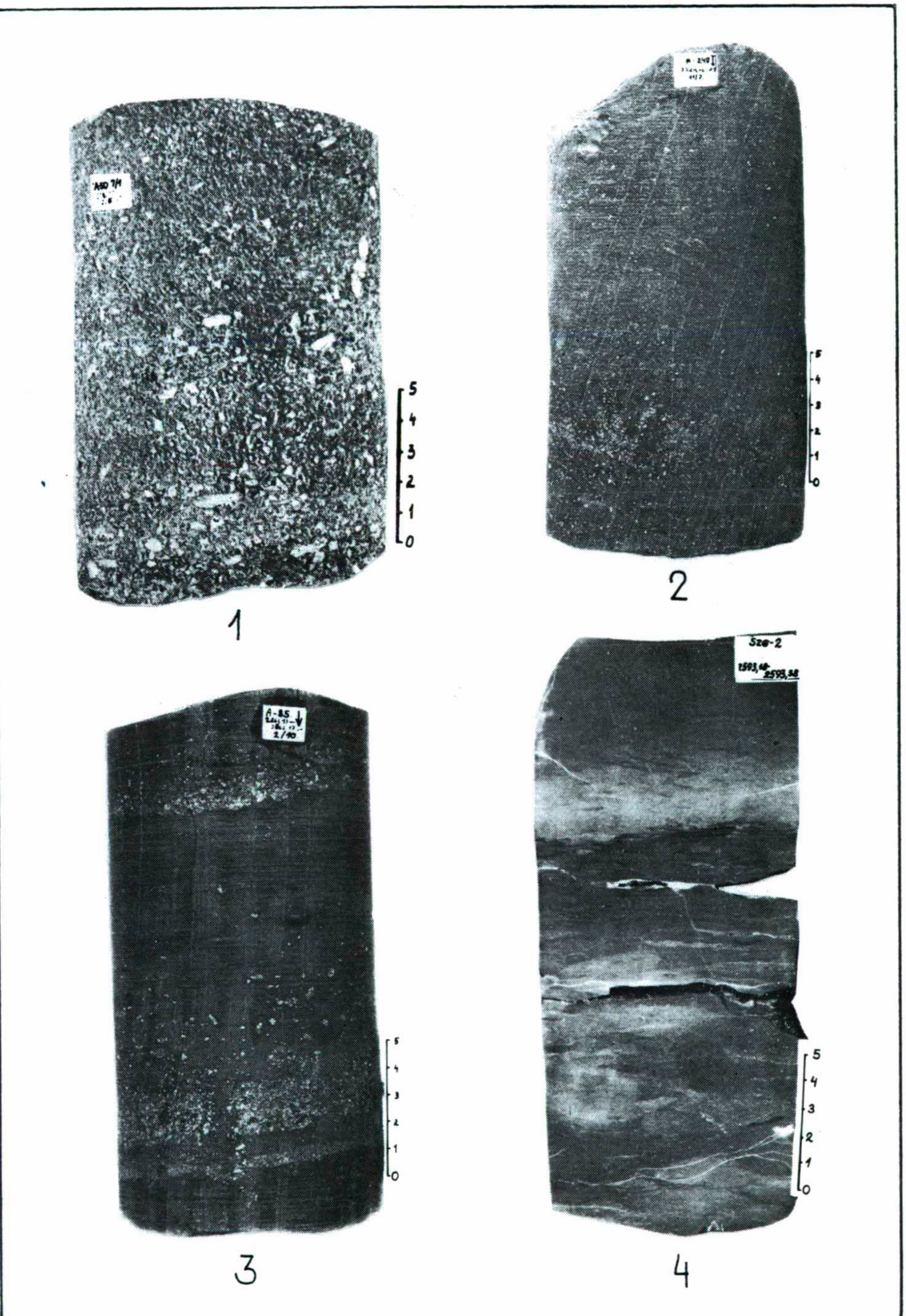
Plate X

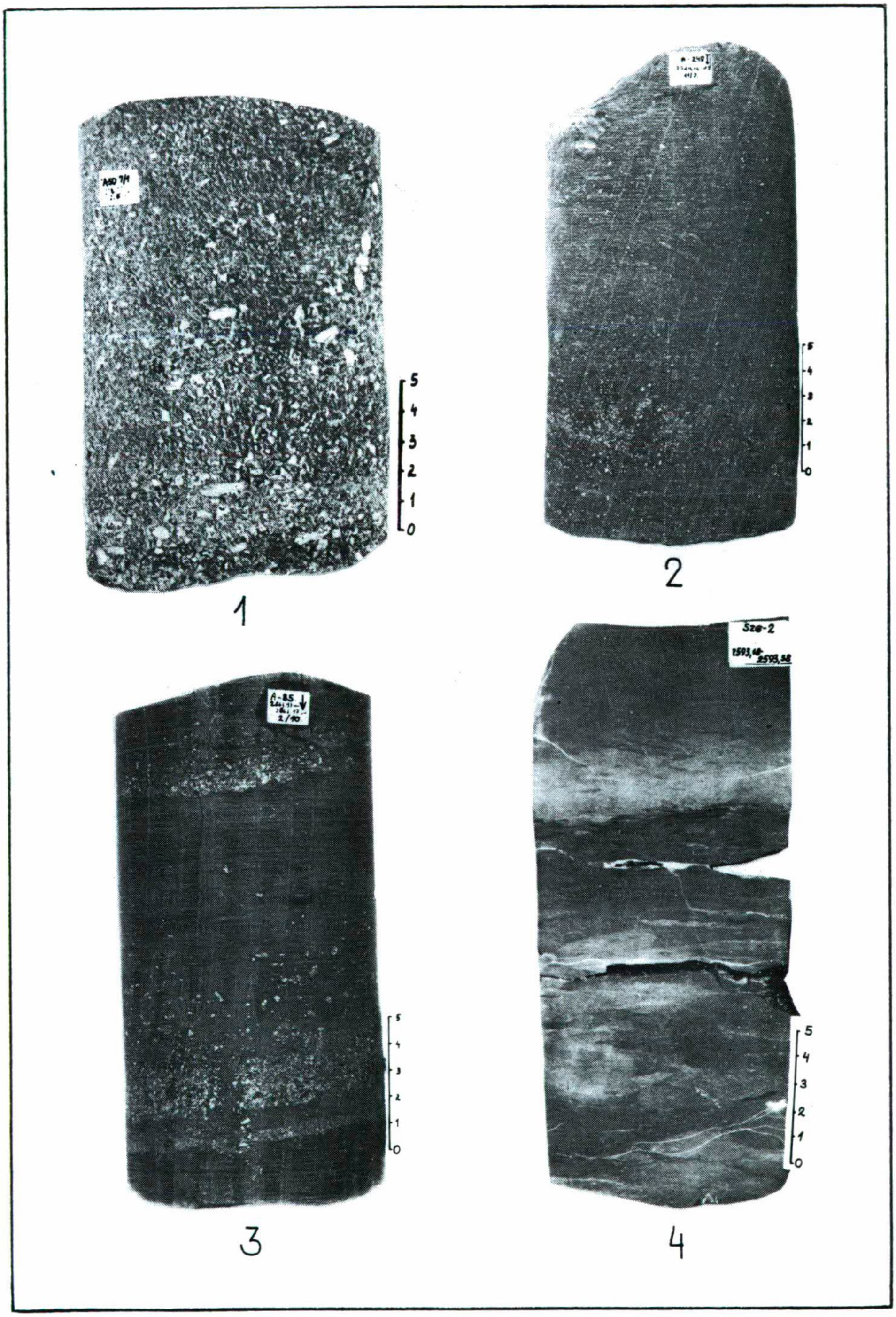
1. Biscuits and bits of fine siltsone with proper lamination embeddεd in a poorly sorted, fine-grained sandstone. — Higher part of the Lower Pannonian. — Well Szeged-9. 2465,60—2465,78 m. Polished surface.
2. A sample from the higher part of the Lower Pannonian attesting the sudden change of the current conditions. Below and at centre: parallel-horizontal bedding proving a stillwater-sedimentation. In the middle of the lower part convolute ripples, on top of the specimen siltstone-pebbles embedded into sandstone. — Well Algyő -264. 2410,65—2410,80 m. Side-view.
3. Filling-up of flute marks on the bottom surface of a fine-grained sandstone bed stepping over to fissil siltstone. — Higher part of the Lower Pannonian. — Well Algyő-83. 2485,93—2485,98 m. Side-view.
4. Composite bedding in higher part of the Lower Pannonian strata. Below laminae of sandstone and siltstone suffered convolution by mud flow. Higher eroded ripples with foreset-bedding. In the middle massive, fine-grained sandstone with small load pockets on the bottom surface. Over this sandstone band planed sand ripples, inside the overlaying siltstone, however, parallel-horizontal sandstone lenses and laminae. In the sandstone lenses oblique or perpendicular tubes of burrowing organisms. — Well Szeged-9. 2714,74—2718,15 m. Side-view.

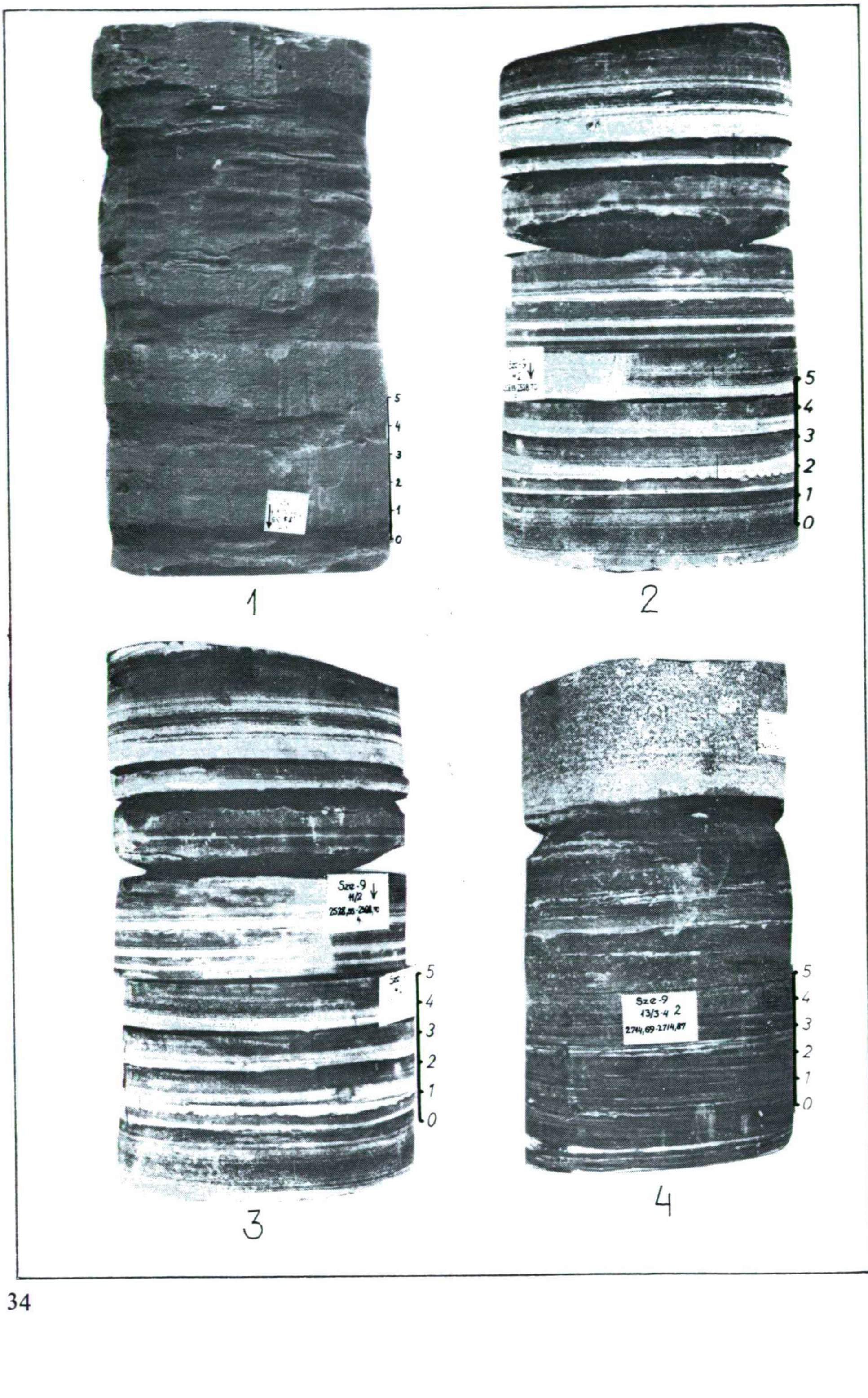

1
2
3
4

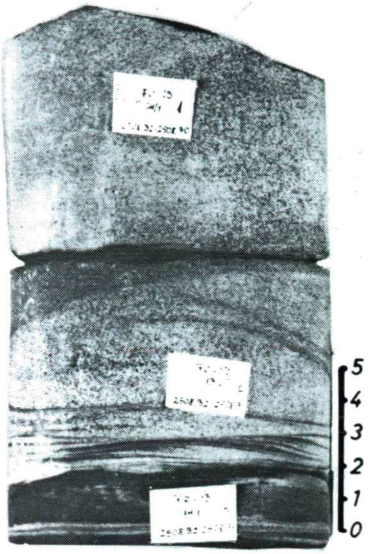



5
4
3
2
1
0
1
Sze-2 12/1c
2656,.. 2665,..
5
4
3
2
1
0
2
5
4
3
2
1
0
3
5
4
3
2
1
0
4

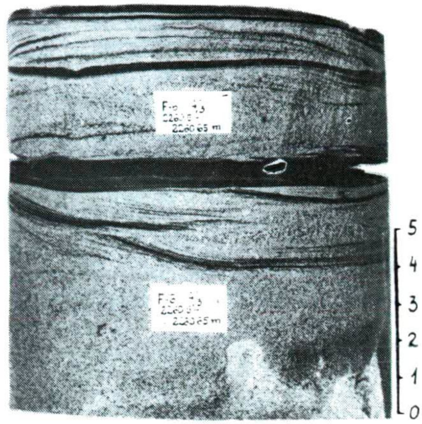

1
2
3
4
Sze-2
2593,48-
2595,38


1
2
3
4
Sze-2

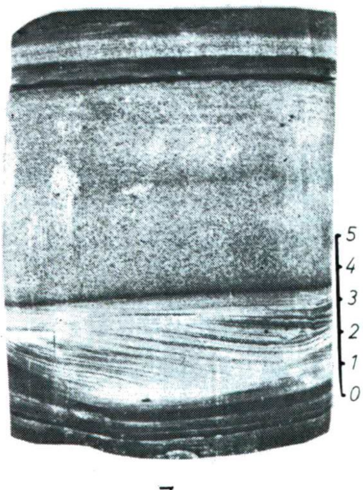

1
2
3
4
Sze-9
Sze-9
13/3-4 2



1



2

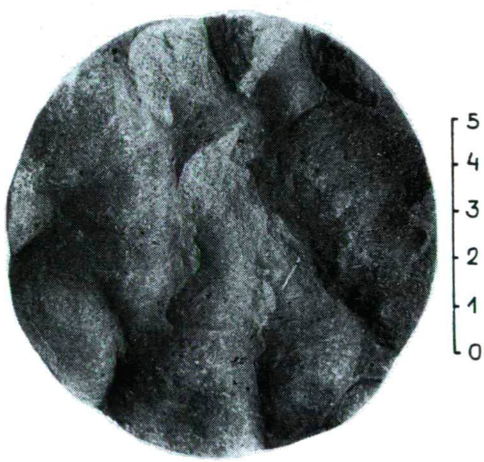


3

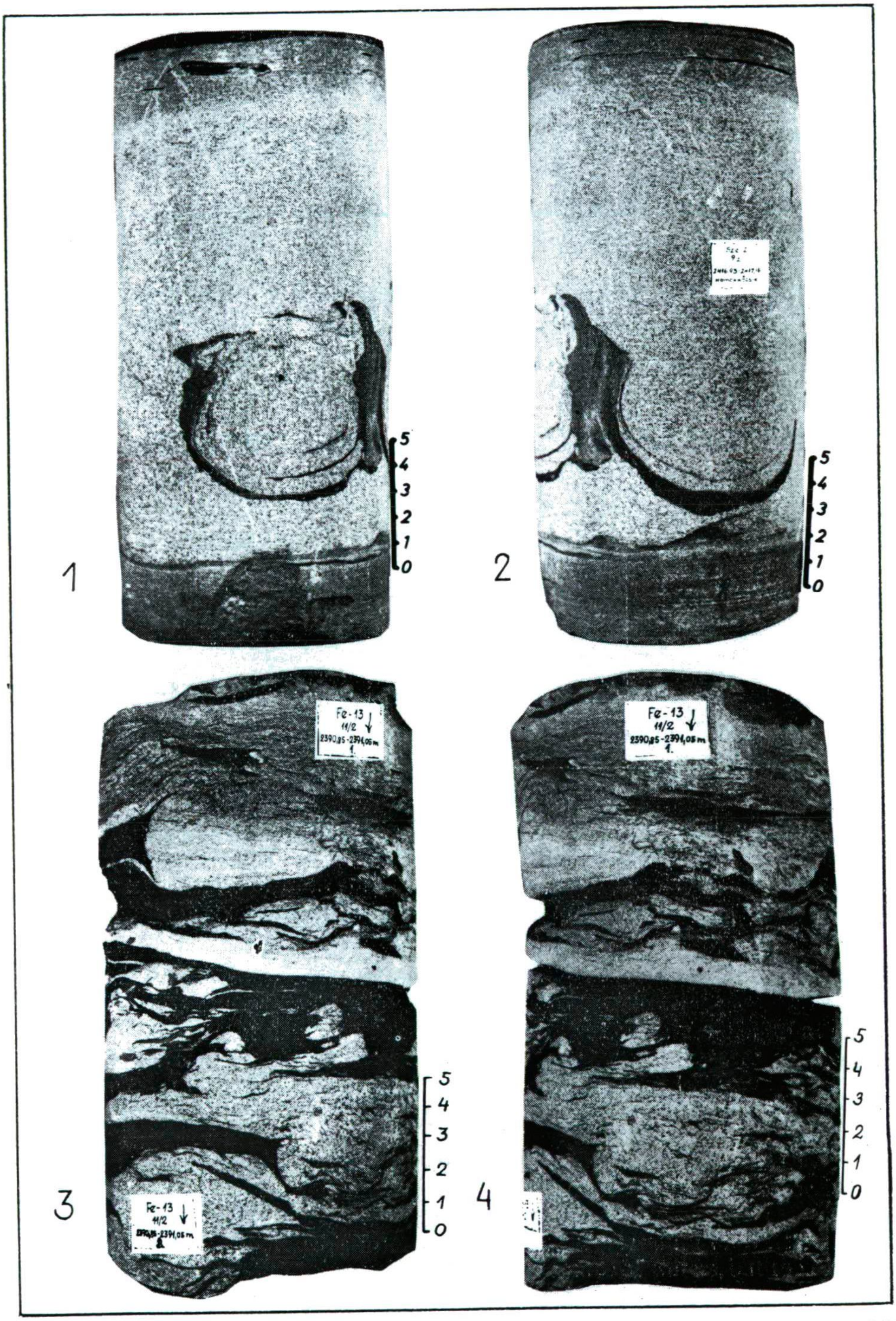
4

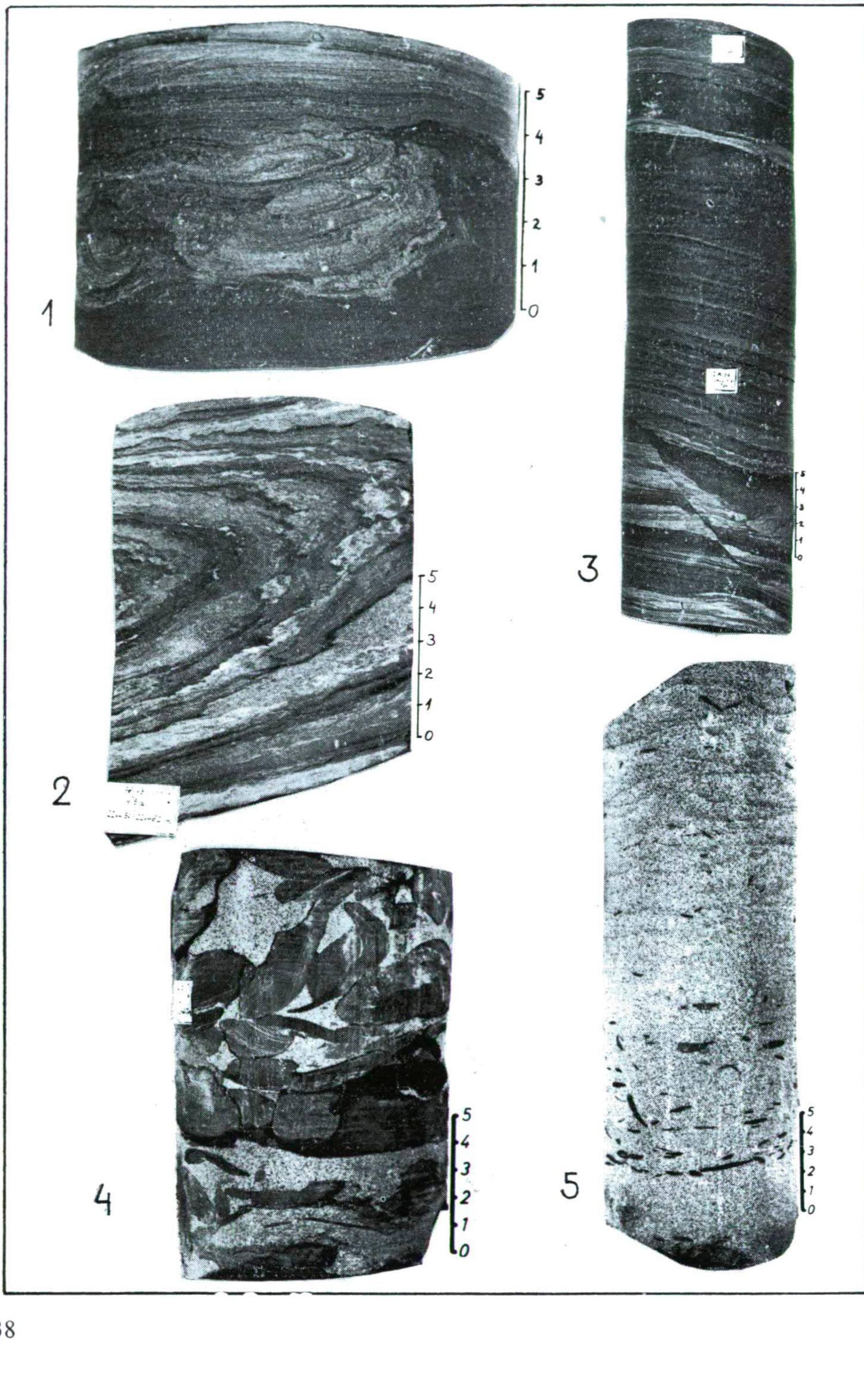
1

2

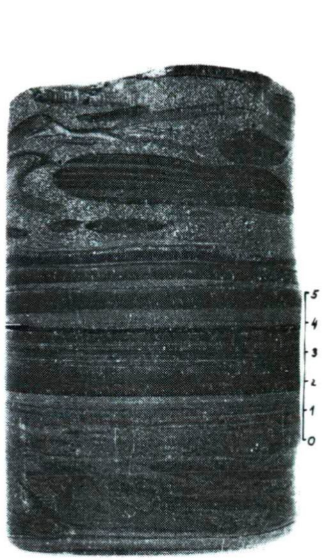


3


1
2
3
4
Fe-13
11/2
2390,85-2391,05 m
5 4 3 2 1 0

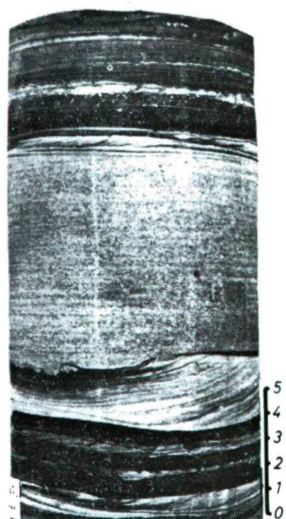


1



2

3



4